Understanding and Monitoring the Cost-Determining Factors of Infrastructure Projects

A User's Guide

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1. Introduction

As is the case with all of the major spending Directorates of the European Commission, DG XVI has an ongoing commitment to achieving value for money in the projects and programmes which it supports. The Directorate has at its disposal a number of mechanisms which it can use to achieve this objective including:

- cost benefit analysis, which is a prerequisite for all infrastructure projects with a value of ECU 25 million or more;
- interim and ex-post evaluations of programmes.

This Guide is designed to further strengthen DG XVI's appraisal capabilities by addressing a particular problem that is encountered with large infrastructure projects: that of cost and time over-runs. It is a fact that very few of the major projects procured with the support of ERDF grant, whether under regional policy programmes generally, or through the Cohesion Fund, are completed within the project sponsors' originally estimated budget and time frame.

Even relatively small cost over-runs can cause disruption when a project is part of a wider programme of expenditure. In extreme cases, where final costs have turned out to be several times higher than originally estimated, the situation is unsustainable. Moreover, it also faces the Commission's desk officers with the problem of assessing the validity of additional financial claims.

One method of assisting desk officers that was considered, but then rejected, would be to compile a set of standard or unit costs for different types of infrastructure. This approach would involve a comprehensive review of actual project out-turn costs for a range of project types. This would need to be done for each Member State or even region of the EU. The rationale behind a standard costs approach is that it would provide a benchmark against which desk officers could assess both new and revised project cost estimates.

The main reason for rejecting this approach is that it does not allow for the extreme diversity of conditions under which projects are implemented in practice, including location, topography, institutional differences and many others. It was decided that the project and programme monitoring role of the desk officers would be better served by improved understanding of the overall project development process, than by a set of simplistic "look up" tables.

The purpose of this Guide is therefore to provide desk officers with a basic understanding of the process by which project cost estimates are made so that they will be better able to review, with the project sponsors, the reasons for actual or anticipated cost and time over-runs. Although it is not a project management manual it does deal with some of the issues that are involved in the implementation of major infrastructure projects within clear cost and time constraints.

The Guide is designed for use by officers of varying levels of experience in programme and project monitoring. It also recognises that infrastructure projects encompass a wide variety of works undertaken in the transport, water, energy and buildings sectors. By their nature, these can be complex undertakings involving a wide range of organisations, both national and international, as well as national agencies and private sector construction companies.

The Guide recognises the principle of subsidiarity, the limited resources available to undertake project appraisals and monitoring, and Member States' requirement to commit large sums of ERDF grant in annual cycles. These factors limit the degree to which detailed and time-intensive project cost appraisals can take place. The objective of the Guide is, therefore, to facilitate more effective appraisals within the limited time available.

The Guide is divided into four main sections.

The first section – ***Understanding the Project Development Process***s – simply explains the stages in the project development cycle, and the roles of the key players in the construction process.

The second section – ***Initial Project Costs and Cost Varying Factors*** – explains the main elements in the initial cost estimate for a project as well as reviewing some of the many factors which lead to changes to the original estimate.

The third section – ***Methods of Controlling Costs*** – discusses the way in which cost and time control of infrastructure projects can be improved by risk management and more realistic estimation of contingency budgets.

The final section – ***An Approach to Cost Appraisal and Monitoring*** – provides a step-by-step guide to improved monitoring of the costs of infrastructure projects.

2. Understanding the Project Development Process

In this Guide an infrastructure project will refer to the development or improvement of land transport systems, public buildings, energy networks, and water supply and treatment works. The basic aim of an infrastructure project is to implement an economically beneficial improvement whose objectives are determined in terms of technical performance, budget and timescale.

The development of infrastructure projects is a complex and resource-intensive process. It is possible, however, to analyse all projects in terms of a common life-cycle which comprises a series of stages. These stages are illustrated in Diagram 1 and brief explanations of each stage follows. Although the stages are illustrated in a hierarchical form, some of the stages can be undertaken simultaneously.

Project Specification and Feasibility

The first stage of the project cycle is the definition of what the requirement is and how it can be satisfied. This includes deciding on the size and quality of facility that is required. Different options will be discussed at this stage and evaluated in terms of broad cost estimates, expected operational performance and economic benefit. Preliminary cost estimates may be attempted at this stage.

Cost benefit analysis, whether formal or informal, will follow initial specification of a project. The purpose is to test whether the project as specified will be economically viable or whether it will generate good value for money. Leaving such feasibility studies until after a project has started, (which often happens in practice!), may mean that potential problems are not revealed in time to influence project planning.

Although the economic and financial evaluation of the project is probably the most obvious element of the feasibility stage, external factors can play a major role in determining whether a project will proceed. The project's political context, its relationship with the local community, the general economic environment, its location and the physical conditions in which it will be built, are the most important external factors.

Outline Design

Work will then be undertaken to develop the plans for the project. These plans will establish the general parameters of a scheme design and will include all the project's major components. The function of outline designs is to provide:

- the basis for the detailed design and accurate cost estimates of the scheme;
- the necessary information for the planning and land acquisition process.

Finance

The financing of a project involves the arrangement of adequate funds to pay for the development and operation of a clearly defined project. In some cases it is also necessary to raise finance to cover maintenance and operation.

For most projects, the main elements of finance will be:

- development finance – to pay for the feasibility and initial design stages;
- construction finance – to pay the capital expenditure;
- contingency finance – to allow for cost overruns and delays.

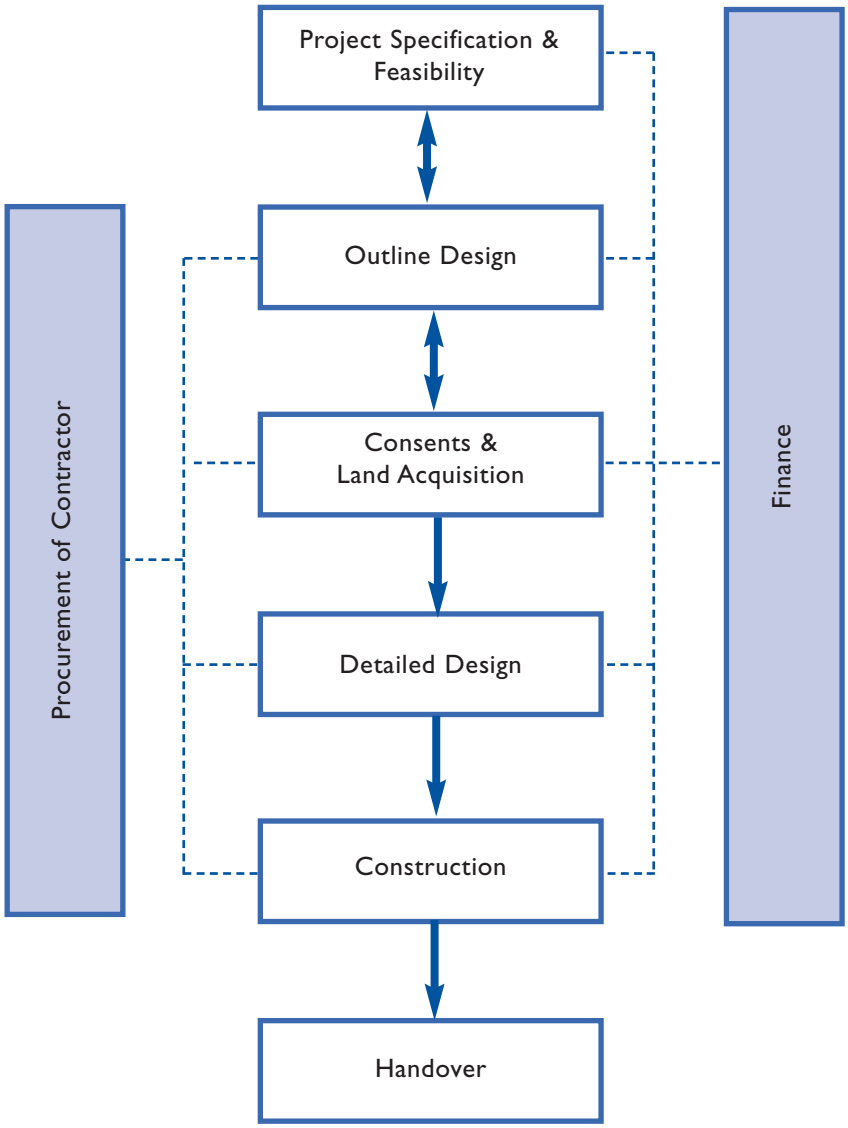
The structure and form of finance will be influenced by the nature of the project. For some projects, the majority of funding will come from local or central government sources; in other cases the project will be revenue-generating and this revenue will be used to pay back loans and pay for maintenance and operation. Some projects may also involve a private sector contribution in which the private sector aims to own and control some or all of the assets.

The structure and timing of financial provision may impose certain constraints on the design and scheduling of the project. For some projects which apply for ERDF funding for example, very little detailed design work will have been undertaken prior to the award of grant. This may be simply because all the funding for the project is not yet in place and/or the risk is too great to commit even the design costs of a project that may not receive a grant.

In other cases, grant may not be required for the sponsor to commence a project and the design and even

Diagram 1

The Project Development Cycle



the construction may be started before a grant is requested. Cases of retrospective grant request also occur, where a project may be almost complete before grant is sought.

Consents and Site Acquisition

Before construction work can start, the necessary consents and authorisations must be in place. The time taken to obtain these is probably the most unpredictable element of a large infrastructure project and can have a significant effect on the timetable and costs. In addition to institutional approval, consents may also need to be obtained for health and safety, water, sewerage, waste disposal, fire certification, gas, electricity and highways rights.

Public consultation is a major element of the consents process in most Member States. Inadequate allowance for required consultation may lead to unforeseen delays in project implementation. **Environmental Impact Assessment** is now required for most large projects before consent is achieved. This also may take more time than anticipated.

A project cannot proceed if the project sponsor does not own or have **development rights** for the land. With projects implemented by local government authorities, the compulsory purchase of land can be undertaken. The existing owners have to be compensated for the purchase and they can usually appeal against the sum offered. Appeals can be very time consuming, although in some circumstances projects may proceed whilst the appeals are being heard.

Detailed Design

The detailed design of a project is used to assess the quantities of materials required and the actual construction work involved in implementing a project. Drawings and lists of quantities are then used to produce detailed project costs and to establish an implementation timetable.

Procurement of Contractors

Project procurement involves selecting a contractor to undertake the construction of the project. The conventional approach to procurement of public sector projects involves advertising for firms to tender for the work. These invitations may be open to all companies or restricted to a shortlist of preferred bidders. All invitations for major projects in the public sector should be advertised in the *Official Journal of the European Communities* in accordance with the Public Procurement Directive.

A contractor will submit a tender which sets out the skills and experience of the company in undertaking the particular type of project, their proposed approach to the construction task, and their estimate of the cost of undertaking the work.

Many projects nowadays involve the procurement of contractors on a “design and build” basis where the contractor submits a design and tender on the basis of a given specification. Some projects may also involve the contractor providing all or part of the finance for building the project and for operating it after completion. Various terms are used to describe these contracts; the most common being Design, Build, Finance and Operate (DBFO).

The Construction Contract

This involves the actual construction of the project. Contractors can be legally bound to undertake the work under a number of different contractual arrangements. Before a contract is agreed, a decision must be taken about the basis upon which the contractor will be paid. The factors which may affect the decision on payment method will include:

- the degree to which design information is available when contract documents are prepared;
- the institutional rules of the public sector funding parties (including the Commission);
- the nature and size of the project;
- the general economic context;
- the time period available to produce tender documentation; and
- the time available to undertake the work.

The following are some different methods of actually paying the contractor for the construction work:

- fixed lump sum, with payment usually on completion;
- target lump sum (as above but with more flexibility);
- progressive payment according to tasks completed, (based on agreed rates for specified tasks or quantities of materials used);
- progressive payment according to human resources expended, (based on an agreed schedule of hourly/daily rates).

If the project's scope and specification has been very clearly defined, or a standard type of project is to be constructed, then the fixed lump sum may be used. The risk is passed fully onto the contractor and the project sponsor cannot usually intervene further in the project.

With the target lump sum approach, the contractor prepares an estimate based on a defined scope of work. Before the project sponsor accepts this sum, there will be an agreement on the respective liabilities of the project sponsors and contractor, if the contract over-runs on costs.

The "tasks completed" or "materials quantities" approach involves measuring construction works according to agreed methods. When the works are priced, their totals plus an element for profit and overheads, forms the contract price. This approach is flexible, can deal with change effectively and is used in valuing the work undertaken during the construction phase. If the estimate of quantities and contract value are to be realistic, the detailed design of the project must have been completed prior to commencement of construction.

If the activities to be undertaken are known but neither the detailed design information nor the scope of the activities are, then a schedule of rates may be used. The contractor is paid, therefore, on the basis of unit rates that have been included in the tender. Usually, this method yields a higher project cost than the tasks/quantities approach because a higher contingency amount will need to be included to allow for the greater uncertainty involved.

Project Handover

A date for the handover of a project from the contractor to the project sponsor is usually included as an element of the contract. For many reasons this may vary from what was originally agreed in the contract. Typical reasons for such extensions are discussed later in this Guide. Many projects include financial penalties (or rewards) for late (early) completion of a project. A percentage of the total project costs may also be retained until the project sponsor is satisfied that the project has been completed as specified.

The Key Players

The key players in the infrastructure development process will vary depending on the institutional structures in the different Member States. The following roles are typically the most important:

- The Project Sponsor/Programme Manager
- Project Manager
- Consents Managers
- Architect
- Costing/Quantity Surveyor
- Engineer
- Contractor.

The Project Sponsor. The project sponsor may be an individual, a private company or a public authority. The project sponsor (or programme manager in some cases), has ultimate responsibility for defining the characteristics of the project that is being procured. It is very important for desk officers to know exactly who the project sponsor is. If this cannot be clearly established, the risk of cost over-runs and even project failure will be high. It is important also to understand whether the project sponsor has any construction expertise or has staff who can work closely with the other members of the project team. If an inexperienced project sponsor has major responsibility for costing, this may lead to poor project cost estimates. It is important from an evaluation point of view to understand exactly what role the project sponsor has in project development.

The Project Manager. The project manager is responsible to a project sponsor for the overall planning, control and coordination of a project and for ensuring that a project is completed within time, on budget and that it satisfies the project sponsor's specifications. The project manager may also be responsible for assembling the project team, assessing the project's viability and securing the funds to implement the project. The project manager's role will vary from project to project. It depends on the degree to which the project sponsor wants to be involved as opposed to delegating the responsibility to the project manager.

Good project managers should be aware of all factors that can threaten the successful implementation of the project. They will ensure that adequate performance reporting is carried out at all stages. This ensures that problems can be identified quickly and measures taken to mitigate them.

Consents Manager. The consents managers include the local authority officials responsible for administering town or regional planning mechanisms, as well as other government agency officials with responsibility for licensing, safety aspects, environmental management etc. They have responsibility for ensuring that the project can legally be implemented in a particular location. At times they may also be involved in undertaking some of the feasibility work for a project and be responsible for assessing the potential environmental and economic impacts of the project.

The Architect. The architect is responsible for designing buildings, public spaces and landscapes. In some Member States the architect also undertakes certain consents duties. The architect may also act as the project manager.

The Costing/Quantity Surveyor. The costing or quantity surveyor, (the abbreviation "QS" is known in some Member States), is the person/s responsible for calculating the costs of a project, preparing tender documentation and also monitoring the value of the work undertaken during the construction phase. The "QS" (or equivalent) may also be responsible for monitoring the project's cash flow. The QS is usually appointed at the beginning of any construction project to advise on costs and alternative forms and methods of construction which may be more cost effective. If a project sponsor wants a change in the project's design or specification during construction, the QS will cost these changes and assist in the decision-making on whether to agree the changes.

The Engineer. Engineers are the main professionals involved in the technical design of projects. There are many different types of engineer but the most commonly used are civil/structural, and mechanical and electrical. Their responsibilities vary between Member States. Civil and structural engineers have expertise in the following types of works: roads, railways, bridges, ports, dams, buildings. Mechanical and electrical engineers are concerned with the design and integration of machinery and electrical systems within infrastructure projects.

Engineers may be hired separately by a project sponsor as design consultants. Alternatively, they may work with a contractor in both design and construction roles.

The Contractor. The contractor is responsible for implementing – actually building – the project. With some forms of contract, however, the contractor can also be responsible for designing the project as well. The contractor may be a single company but in some larger projects, two or more contractors may work together in a consortium. Most contractors usually employ smaller sub-contractors to undertake discrete and specialised work.

3. Initial Project Costs and Cost Varying Factors

This section first focuses on the factors that determine initial project costs and then examines some of the more important determinants of cost changes over time.

3.1 Key determinants of initial project costs

No two infrastructure projects will cost the same amount of money no matter how similar they are. Apart from basic technical factors, the wide range of economic and institutional conditions in different Member States will itself always lead to variations. Nevertheless, the fundamental project costs are based on the actual cost of the land, materials, equipment and labour in the region where the project is being procured. These basic costs will vary depending upon a number of factors which are discussed below. Diagram 2 summarises these factors.

The Project Specification

The specification defines the physical attributes of a project. With a road, for example, given levels of forecast traffic will lead to specification of the required length, depth and width of the road pavement, the material to be used for surfacing, the number of lanes, bridges and junctions etc. For buildings, the required function and expected occupancy rate will lead to a specification of total floorspace and floorplate size, height, internal and external appearance, floor loadings, heating and lighting requirements etc.

Generally, the more detailed the specification and the larger the project, the more expensive it will be.

Location

Location affects project costing via institutional factors and through geographical realities.

Institutional factors can affect initial project cost estimates in a number of ways. Consents procedures in particular may be more arduous in some countries, affecting the time it will take to successfully implement a project. Allowance for the costs involved in sustaining a long public consultation exercise is an example. Where major projects are likely to be strongly opposed on environmental grounds, more cost may have to be allowed for environmental mitigation measures.

In geographical terms, construction and material costs, land costs and design standards vary widely across the EU because of the varying distances from suppliers, climate and weather conditions, and general market conditions. Even within a country, variations will exist depending on whether a project is being implemented in a peripheral or central area, or in an urban or rural context.

Generally, the more remote a project is, the more expensive it will be because of the cost of transporting construction materials and equipment to the site. In an urban location, land costs are usually much higher.

Form of Procurement/Contract

As explained in Section 1, the form of procurement and contract used by the project sponsor can alter the estimated cost of a project. Cost savings may be made by means of lump sum contracts although these are usually marginal in relation to the total project costs. DBFO contracts, which seek to transfer most of the risk of cost over-run from project sponsor to contractor, may in some circumstances yield savings.

Site Characteristics

A site can be affected by soil and drainage conditions and access restrictions which can affect the original cost estimates. The amount of excavation, piling and foundation activities required are particularly affected by poor ground conditions. Where there is uncertainty about ground conditions, accurate project costing cannot be achieved unless a soil survey is undertaken. This may require the sinking of boreholes to obtain soil samples at different levels beneath the surface.

New Build or Improvements

Generally, the construction of new infrastructure is more expensive than improvements to existing infrastructure, or the refurbishment of buildings. This is primarily because the “non-building” costs such as land purchase, foundations, services provision etc. do not have to be included when simply upgrading existing structures.

Tax Liabilities

An organisation will be liable to pay tax on its purchases. Some organisations and types of project are not liable to pay taxes, or else these can be reclaimed. Local government projects and infrastructure for public use are examples. Some public or quasi-public sector companies, voluntary and private sector organisations can be liable and these tax costs can have a significant impact on gross construction costs.

Timescale

Generally, the longer a project takes, the greater the project costs will be. Project timescales are dependent on the specification of a project. Usually, the larger a project is the longer it will take to implement. This is not always the case; if substantial additional resources are used, project implementation can often be accelerated.

In some cases, work on a project may take a lot longer than expected because its phasing is dependent upon other, linking projects or public finance programmes. A project which involves non-continuous phases is usually more expensive than one undertaken without interruption because of the additional costs involved in re-mobilising plant and contractors.

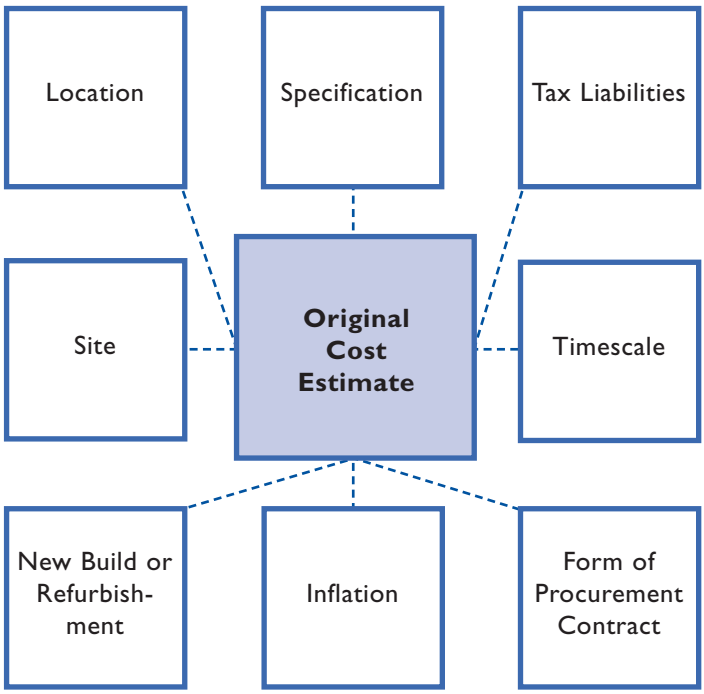
Inflation

The longer the expected construction period, the more account will need to be taken of expected inflationary price increases over time. This is particularly important where a public authority's expenditure programme is involved. Initial cost estimates will need to allow for the value that will need to be paid at the time the project actually goes ahead.

Levels of inflation vary amongst Member States and can be as low as 1-2% or as high as 10% per annum. In some of the states that will accede to the EU in future, higher inflation rates may be more typical.

Diagram 2

Key Determinants of Costs



3.2 Factors which change costs over time

Once implementation begins, a project's costs rarely remain static. As further information becomes available the costs may be further defined. Yet, even when a cost has become firmly fixed, there are numerous factors that can lead to the cost increasing. Delays are a major factor. Whatever the reason, delays almost invariably increase budget costs. Many events may have contributed to the delay – some which could have been foreseen and others which could not.

In the context of EU programme funding, time and cost over-runs have obvious implications for the number of projects that can be funded within a programme period, and for the scale of the outputs and impacts generated. Research carried out in the preparation of this manual has found that many ERDF projects experience a range of problems in both the pre-construction and implementation stages. These lead to projects over-running either in time or costs. As indicated above, delays generally translate into higher project costs.

A key consideration in the context of EU funding is the time at which an application for funding is actually made. Applications can be made at three main points in time:

- very early in the construction cycle when broad cost estimates only are available;
- on the basis of tender prices for the work to be undertaken;
- retrospective bids where the project has been completed but grant is still required.

The level of certainty about the final or outturn costs will vary for each of these three situations. Obviously, if an application comes forward very early in the project development cycle, then there is a much greater chance that the project will experience time and cost over-runs.

Diagram 3 illustrates some of the factors that result in projects being delayed or costing more than originally planned. The Appendix to this Guide also includes case studies which illustrate how some of these factors have affected actual projects.

Poor Project Management

The role of the project manager or project management team is probably the most important element in containing the costs of a project. It is often true that a poor project with a good project manager will be completed satisfactorily. But even a good project, if combined with poor project management, will almost always face serious difficulties.

A poor project management structure will have an impact at all stages of the construction process leading to:

- a lack of planning and coordination;
- poor communication between members of the project team and the project sponsor;
- failure to identify problems and institute necessary design and programming changes;
- a lack of control over time and cost inputs.

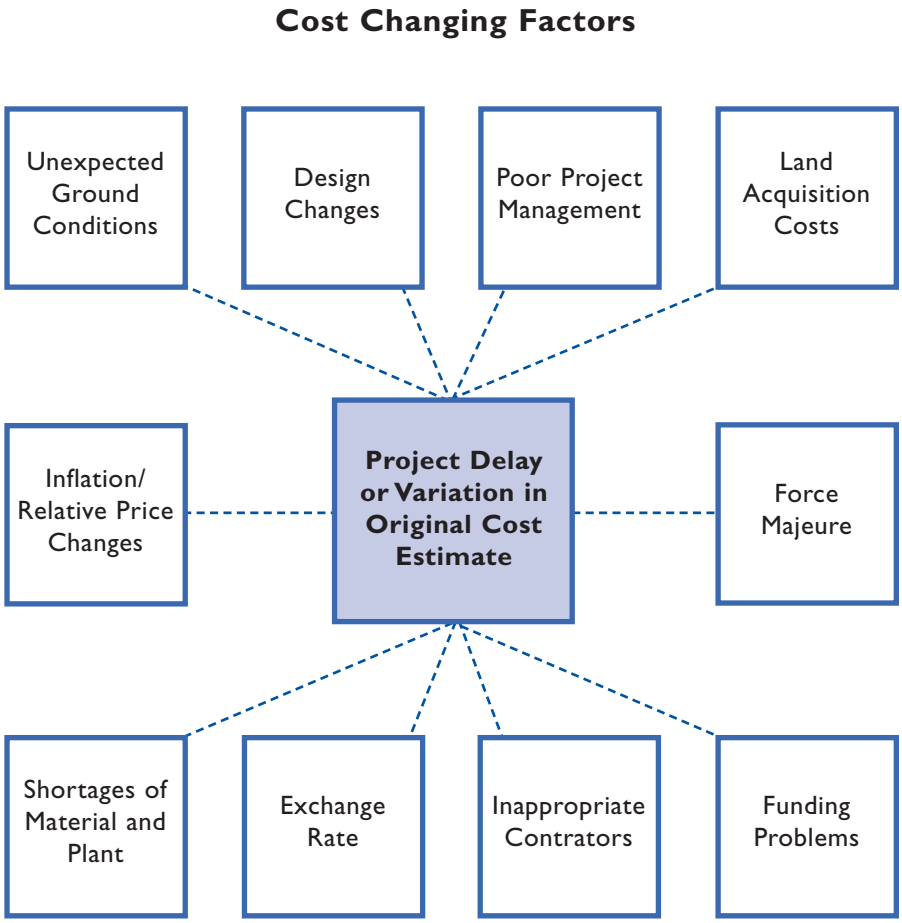
Design Changes

A change in a project's design can arise for a number of reasons. It may be that the project sponsor wants additional elements to be included in the project or changes to existing ones. Usually, these design changes require additional time inputs from architects and engineers as well as the additional time and cost inputs from the contractor and for additional materials.

Unexpected Ground Conditions

Ground conditions can be assessed by a desk-based review of relevant published documentation and through the use of trial pits and borehole sampling on-site. However, the actual site conditions for the full extent of a project are not usually determined until construction begins. It is possible that difficult conditions are overlooked by the initial review or that conditions have changed due to adverse weather conditions or changes in sub-soil conditions. Unexpected sub-surface conditions can, at times, require fundamental redesign of projects at great expense. Changes in surface ground conditions can lead to problems in actually moving machinery and supplies around the site, and in undertaking excavations and laying foundations. This can also increase costs and add to the construction time required.

Diagram 3



Inflation

As noted earlier in this section inflation can act to increase the original estimates of construction costs. Inflation may have been taken into account in the original estimates, but if the rate of inflation increases above the predicted level during the construction period, then the original cost estimate will be exceeded. Obviously any other factor that delays a project will expose the project to the risk of further inflationary cost increases.

Inflation may not be the only cause of price rises. Political or technological factors may affect one or more element of costs; for example, increased labour mobility between Eastern Europe and the EU, (which may occur after the accession of the Eastern states), could in future lower the labour cost element of construction projects.

Shortages of Material and Plant

During periods where the level of development activity is unusually high in a particular region, there may be

shortages of some construction materials, construction plant (machines and equipment used during construction) and service plant (equipment used in the operation of the infrastructure project). If this was not anticipated in the original cost estimate, delays may occur and/or the prices of these elements increase.

Exchange Rates

The exchange rate is particularly relevant if contracting services or other elements of the project are being purchased from other Member States or from outside the EU. If exchange rates change beyond the level predicted by the project sponsor (and the companies providing the services) then the cost of the project can increase. It can of course operate in the opposite way where the project sponsor takes advantage of a strengthening of his own currency. Of course the EU's Exchange Rate Mechanism and the Single European Currency project are designed to minimise and, eventually, eliminate such problems.

Inappropriate Contractors

Contractors are selected on the basis of price, experience in undertaking particular types of project and their track record in producing high quality work within budget and on time. Problems may arise where there is a high level of development activity being undertaken in a particular region and the better contractors are not available to bid for the work at that time. Alternatively, the tender review process may not have been undertaken by the personnel with the best understanding of the services required. As a consequence, firms which are not the most experienced in that field of activity are chosen, often with implications for the quality and cost of a project.

Delays in project implementation and increases in costs can arise through the use of ineffective or inappropriate labour, or errors in calculating how productive the labour will be. This can happen especially when sub-contractors are used whose quality is not controlled in the main project contract.

In most cases there is a trade-off between price, experience and track record but the desire to accept the lowest tender does not always lead to a project that is completed within time and budget.

There are cases of contractors and sub-contractors who go into liquidation during the construction period. This can lead to significant delays and extra costs arising as the project sponsor has to re-tender the remaining work. Identifying a new contractor to complete another contractor's work is difficult because of the possible liabilities that the new contractor would have to accept for another company's work.

Funding Problems

The overall lack of finance to complete a project, or delays in the payment for services by the project sponsor can lead to significant problems arising. If the costs of a project have increased significantly beyond the original estimate, then work on the project may have to stop or be delayed until additional funds can be found.

Funding problems can also arise if funds allocated to one project have been diverted to other projects within a programme of development.

If the payment of invoices by a project sponsor is slow, the contractor may begin to commit less resources to a project, and may even cease work if cash flow becomes a problem.

In some cases, even when a project is expected to be entirely profitable, project sponsors may understate the availability of local funding simply in order to maximise the level of grant. This can happen with revenue-generating projects particularly. Such practices can reduce the availability of funding for other projects.

Land Acquisition Costs

The land on which a project will be built is not always owned by the project sponsor. Where this is the case, local government authorities can usually compulsorily purchase the land in accordance with legal statutes. The statutes usually require that the land (and any properties on it) are valued and that compensation is paid to the owner on the basis of the valuations. Although the right to purchase and actually develop the land can be agreed relatively quickly, the amount of compensation that actually has to be paid can sometimes not be agreed until the end of the project, especially if the land owner appeals against the original valuation. The owner may have the right to appeal and it is up to a Court to agree a fair price for the land. In many cases, this may be greater than the original forecast by the project sponsor. Inevitably, long drawn-out compensation cases will delay a project.

Force Majeure

This term covers a range of events which are also commonly referred to as "Acts of God". They include

revolution, war, riot, extreme weather, earthquake, landslip, fire, political and economic instability. Usually, the contractor is required to insure against such events happening. Where they do occur, they will normally lead to significant delays occurring and, consequently, cost increases.

Other Factors

In addition to all the categories listed above, experience shows that problems also arise from premeditated under-estimation of initial costs simply in order to obtain initial approval for a project. This can lead to major projects being approved, and started, in the knowledge that actual costs will be very much higher than the "agreed" estimate. Once started, a high profile infrastructure project is often politically difficult to stop. So, when the true costs do become apparent, it is difficult for authorities to refuse the additional funding required to complete the project.

3.3 Typical analysis of project costs

As well as understanding the process by which cost estimates are calculated and how they may vary during construction, it is worthwhile having some understanding of how important the different cost elements are, and how sensitive they may be to a range of cost varying factors. The tables following this page provide a general analysis of the typical proportion of total project costs acccounted for by major cost elements. The tables are not absolute benchmarks but are designed to guide desk officers in their general understanding of the relative significance of different cost elements and cost varying factors.

Table 1 provides estimates, for seven different types of infrastructure projects, of the typical proportion of total project cost that is accounted for by specific categories of cost. A range is given to show how proportions may vary from project to project.

The matrix in Table 2 gives an indication of the degree to which some of the cost categories may change in response to the influences of the main cost-changing factors identified. In this table, "Site Preparation" has been listed as a separate element of "Building & Construction" cost. This is because unexpected problems with ground conditions most frequently impact on the cost of site preparation works.

The ranges given for the different categories making up initial costs, (Table 1), may enable desk officers to judge whether or not particular project submissions need to be interrogated. If, for example, a project indicates that land purchase costs for a sewage treatment plant amount to 10% or more of total costs, a desk officer should be alerted to ask questions. This is because in typical projects of this nature, land purchase costs do not exceed 1% of total costs.

Again, if a project sponsor indicated that poor ground conditions was the reason that plant and machinery costs turned out to be higher, the desk officer would need to interrogate the project. This is because Table 2 shows that, typically, unforeseen ground conditions are only likely to significantly affect site preparation costs (part of the construction costs). Plant and machinery costs are most unlikely to be affected by this factor.

Table 1

Major Cost Elements and Indicative Share of Total Cost for Seven Infrastructure Types

	Motorway Dual (1 km) Rural Area	Motorway Dual (1 km) Urban Area	Sewage Treatment Plant 50,000 people	Water Supply Network (1) 50,000 people	Public Building (2) 15,000 m^2	Energy 1 (3) CCGT Power Station	Energy 2 (4) City Gas Distribution Network
Planning/Design Fees	3-5%	3-4%	3-5%	5-7.5%	10-15%	5-10%	5-10%
Land Purchase	3-5%	20-30%	0-1%	1-2%	5-15%	0-10%	0-10%
Building & Construction	75-80%	60-65%	40-41%	75-80%	25-38%	15-30%	20-35%
Plant & Machinery	na	na	40-41%	na	10-18%	50-60%	40-50%
Contingencies	10%	10%	10%	10%	10-15%	10-20%	10-20%

Notes: Because a percentage range is given for each cost element, columns do not sum to 100%

1. *10 km pipeline from existing reservoir with new treatment plant and new mains network*
2. *Eight storey building in urban area with offices and function rooms*
3. *60 MW station with 20 km of transmission lines feeding into main grid, sufficient for a settlement of 50,000*
4. *LPG storage plant with 500 km pipeline network (15% primary distribution, 85% secondary distribution), 250,000 population*

Table 2

Effect of Cost-changing Events on Key Cost Elements; (Major or Minor)(1)

	Cost-changing factors					
Cost Elements	Design Changes	Land Acquisition Problems	Poor Project Management	Unexpected Ground Conditions	Inflation/ Relative Price Rise	Difficulties with Contractors
Planning/Design Fees	●	—	●	—	•	—
Land Purchase	•	●	•	—	•	—
Site Preparation(2)	•	—	•	●	•	•
Building & Construction	●	—	●	•	●	●
Plant & Machinery	●	—	•	—	●	•

Notes:

1. *Large dot denotes a major effect – potentially 20% change for affected cost elements*
   Small dot denotes a minor effect – typically 5% change or less for each cost element affected.
2. *"Site Preparation" is identified as a separate element of Building & Construction costs because it is here where the main effect of unexpected ground conditions is experienced.*

Source: (Both tables) – Researched by consultants, Ove Arup & Partners, based on experience of public and private sector procured projects in various EU Member States.

4. Methods of Controlling Costs

The purpose of this section is to review ways in which the cost and time management of projects can be improved by risk management and by more realistic estimation of contingency budgets. Whilst this is ultimately the responsibility of project sponsors and their project managers, an understanding of the principles involved should also be of value to desk officers and other users of this Guide in the Commission.

4.1 Uncertainty in project costings

The preparation of project cost estimates is a difficult task because construction projects are subject to risks and uncertainties, particularly in the early stages when very limited information about the project is available. Yet, the cost estimates prepared at this stage are most important to the project sponsor because they often form the basis of the bid for funds.

As a project progresses, more information becomes available to allow costs to be calculated to a greater degree of accuracy, for example the ground conditions on-site or the specific types of plant or machinery that will be provided. More reliable cost estimates become available after tenders have been received from contractors.

Nevertheless, many aspects remain uncertain and normal costing practice is to include an extra element to provide "insurance" against cost over-runs. The word "contingency" is usually used to describe this additional cost element. As was shown in Table 1 different amounts are typically allowed in different types of projects.

The contingency is typically based on a "rule of thumb" calculation, as a certain percentage of the base cost estimate or a lump sum based on the experience of the estimator. A figure of 10% of gross costs is a common allowance. This risk allowance or contingency sum is often calculated only once and is not reviewed again as the project progresses.

The main weakness of this simple approach to contingency costing is that individual risks are not separately evaluated. As a result, a contingency is often set too high for low risk projects, or too low for high risk projects. In addition, it is not always appropriate to carry a specific contingency allowance for the duration of a project since many of the risks become known and can then be eliminated.

4.2 Risk and contingency planning

By giving greater attention to which cost determining factors are most likely to change, and why, project sponsors should be able to develop more accurate contingency estimates. This in turn should reduce the risk of cost over-runs. Poorly managed risk affects the ability of a project to be completed within time and on budget. On the other hand, the level of risk can often be reduced if project sponsors take the time to identify, assess and manage the main factors leading to cost escalation.

Although a potentially complex subject, risk management basically involves three quite simple stages:

- risk identification: what could go wrong?
- risk assessment: it is possible to quantify or at least rank any of the risks?
- risk management: what steps can be taken to mitigate or manage these risks in order to prevent cost over-runs?

Once the risks have been identified and assessed, they must be continuously monitored until the end of the project. Although careful risk assessment typically results in an increase in initial cost estimate, it usually leads to a reduction in contingency. Risk management measures are worthwhile because they lead to a more certain final project cost.

Often it is not clear what is actually contained within a project's contingency budget. As noted above, it could just be a general percentage estimate. In careful risk management the contingency allowance for larger projects should cover three main types of contingency:

- **Special risks contingency** – an allowance to cover the risks arising from higher land acquisition costs, changes in external factors such as the availability of funds, statutory requirements and force majeure. It can also cover the risk of a project sponsor changing his mind about the project specification (a fairly common occurrence!).

- **Design contingency** – an allowance for use during the technical design process to provide for the risks of changes due to design development or in estimating data.
- **Construction contingency** – an allowance for use during the construction process to provide for the risk of changes due to site conditions or as a result of changed construction methods or poor performance by contractors or sub-contractors.

The use of a better specified contingency will only be effective if suitable project control procedures are in place to control all aspects of project performance. Project control procedures should be organised and managed by the project manager. They should provide essential, coherent management information so that the project sponsor and project manager can react to changing circumstances.

4.3 Project management

Finally, improved contingency planning can never be a substitute for good project management.

The essential elements of good project management are:

- **Cost control:** managing the design and construction processes to achieve best value for money and ensuring that the final cost does not exceed the budget.
- **Time control:** managing the design and construction processes so that the project is completed on or before the agreed completion date.
- **Quality control:** ensuring that the quality and performance of the completed project meets the project sponsor's original objectives.
- **Change control:** ensuring that any changes that are necessary are achieved within the approved budget, that they represent good value for money and that authorisation to proceed has been obtained from the project sponsor.

5. An Approach to Cost Appraisal and Monitoring

5.1 Project interrogation

The purpose of this section is to provide desk officers with a set of questions to ask and issues to consider when appraising project applications or when monitoring ongoing major project claims. It should be used in conjunction with the existing appraisal systems for ERDF funds and the regulations of the Programme in question.

The various issues are based upon the preceding sections of the Guide which have identified the main factors that can lead to time and cost over-runs. The appraisal questions suggested here are not designed to ensure that all projects will be implemented without any problems. They are to assist the desk officer to explore the factors that can contribute to an ill-conceived project being approved and to understand why an existing project is requesting additional grant during the implementation stage.

In most cases, the initial project submission should address all of the relevant issues and satisfy the desk officer regarding the validity of cost estimates. It is also important that all sections of the application form are completed, particularly those in relation to costs. Where there are gaps in the cost details provided, it is often not clear whether the cost heading is not relevant to the particular project, or has perhaps been combined with some other cost, or even that the sponsor has simply failed to insert the relevant figure. Interrogation may be necessary to establish the actual position. The desk officer should raise any queries with the project sponsor or refer the project to appropriate specialists if the issue cannot be resolved.

Diagram 4 divides the project development cycle into six stages. For each stage, parallel groups of project interrogation questions are also included. These groups of questions are discussed in the following text as "Risk Issues". Some questions are relevant at more than one stage. When interrogating a project, desk officers should first establish the stage of development of a project and then use the relevant questions.

The diagram also shows graphically how risk (of cost and time over-run), decreases as a project progresses.

Risk Issue 1: Project Specification & Feasibility

The key issues concerning the project's specification and feasibility relate to whether there is a need for the project and whether a budget cost (the maximum cost a sponsor will wish to pay for the project) has been identified by the sponsor. It would also be appropriate at this stage to check if a Cost Benefit Analysis has been undertaken and a project manager with proven experience appointed.

The project description should not be technically complex. The project's objectives should be clear, consistent throughout the submission, and achievable. Simple questions should be asked such as:

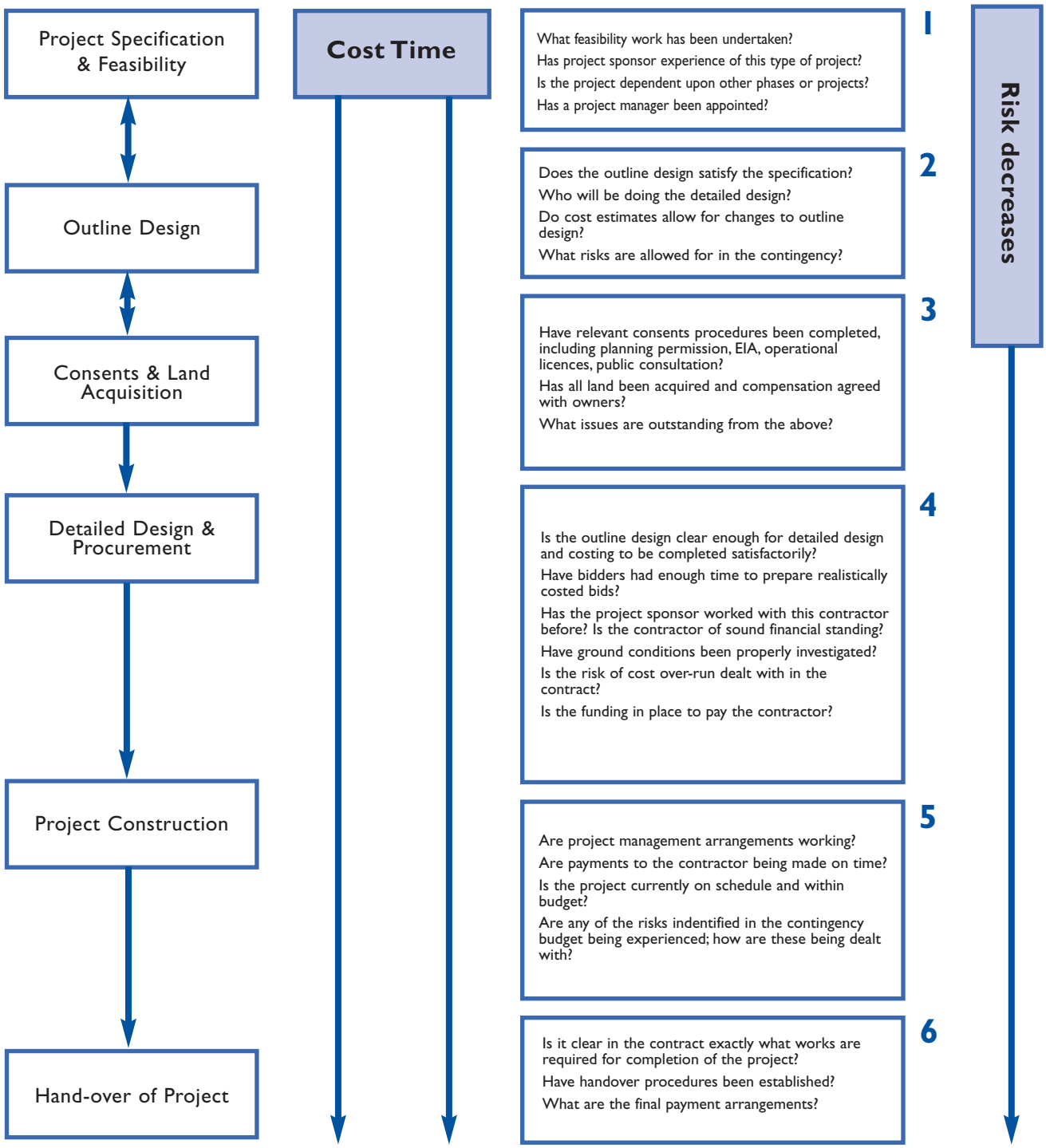
- where is the project being undertaken?
- what exactly does the project comprise?
- why is the project being undertaken – what is the demand?
- what previous phases have been undertaken and what phases are not included in the application (including costs)?
- is this project directly dependent upon any other projects?
- who is undertaking the project and over what time period?

Risk Issue 2: Outline Design

At the outline design stage, the key issues are whether the size of the project matches the identified needs, or whether it is over-designed. It is important to establish how much more design work will be required and what role the contractor will have in this process. If cost estimates are based on outline designs only, then the potential for costs to change is greater than if they had been finalised.

For large projects it would also be appropriate for a Risk Assessment Study to have been undertaken by this stage. This would show that the project sponsor was aware that specific risks existed which could affect project costs. This would form the basis for the calculation of the contingency budget. It should be possible for the appraiser to establish how the contingency was calculated and what risks it covered.

Diagram 4


The Project Development Cycle
Project Specification & Feasibility
Outline Design
Consents & Land Acquisition
Detailed Design & Procurement
Project Construction
Hand-over of Project
Cost Time
Risk Issues
What feasibility work has been undertaken?
Has project sponsor experience of this type of project?
Is the project dependent upon other phases or projects?
Has a project manager been appointed?
1
Does the outline design satisfy the specification?
Who will be doing the detailed design?
Do cost estimates allow for changes to outline design?
What risks are allowed for in the contingency?
2
Have relevant consents procedures been completed, including planning permission, EIA, operational licences, public consultation?
Has all land been acquired and compensation agreed with owners?
What issues are outstanding from the above?
3
Is the outline design clear enough for detailed design and costing to be completed satisfactorily?
Have bidders had enough time to prepare realistically costed bids?
Has the project sponsor worked with this contractor before? Is the contractor of sound financial standing?
Have ground conditions been properly investigated?
Is the risk of cost over-run dealt with in the contract?
Is the funding in place to pay the contractor?
4
Are project management arrangements working?
Are payments to the contractor being made on time?
Is the project currently on schedule and within budget?
Are any of the risks indentified in the contingency budget being experienced; how are these being dealt with?
5
Is it clear in the contract exactly what works are required for completion of the project?
Have handover procedures been established?
What are the final payment arrangements?
6
Risk decreases

Risk Issue 3: Consents and Land Acquisition

The appraiser should be aware of what stage the project sponsor has reached with regard to consents and land acquisition. A project can experience considerable delays which may affect costs if the appropriate planning, environmental and other consent procedures have not been adhered to.

As regards land acquisition it is important that the appraiser is aware of whether all claims have been settled or if there are any appeals over compensation. If appeals have not been settled then there is a high probability that any original land acquisition costs will be an underestimate.

Risk Issue 4: Detailed Design

At the detailed design stage, the procurement of contractors to undertake the construction work can take place. In some cases, appointment of contractors may precede the detailed design stage. The form of contract and the respective roles of project sponsor and contractor in bearing risk for the ultimate project cost, are matters that desk officers should inquire about, especially where there appears to be uncertainty in this area. It is also important to establish that procurement regulations have been followed and that the contractor has relevant expertise and experience.

Desk officers should check whether ground investigations have been undertaken. If these have not been done, then the risk of cost over-run increases and the contingency should reflect this.

Risk Issue 5: Project Construction

During the construction phase, there needs to be a project management structure in place which allows frequent reporting of progress to be made between the contractor and the project sponsor. Most of the time and cost over-run factors that can occur, do so during the construction phase. The appraiser must therefore establish that the main risks taken into account in the contingency calculation are being managed on site.

Risk Issue 6: Handover of Project

The project sponsor should state when the project is scheduled to end. It should be clear whether the project will be complete and fully operational once the ERDF grant has been used, or whether further phases have to be implemented.

5.2 Conclusion: use of this guide

The purpose of this Guide is to improve desk officers' understanding of the project development process. This is so that they will be in a better position to interrogate those projects where there is reason for concern over initial project costs, or changes in these costs.

The Guide will serve as a further tool within the overall evaluation framework for which DG XVI has responsibility. As such, it may be used alongside other documents including the Commission's Guide to Cost Benefit Analysis of Major Projects and the Structural and Cohesion Fund regulations.

It is unlikely that the Guide will resolve all problems related to cost and time over-runs. Nevertheless, by improving the ability of desk officers to probe projects where there is concern about the cost structure or changes in costs, it is hoped that project sponsors in the Member States will themselves be steered towards progressively better practice. This will ultimately be in the interest of Member States' development programmes. This is because more robust costing of individual projects will mean it is less likely that funds will have to be diverted from other projects or programmes, to cover cost over-runs.

Use of the Guide will not eliminate the need to refer difficult cases to specialists when necessary. Neverteless, when desk officers have become familiar with the principles and practices outlined in the Guide it may be that less frequent use of such specialist services will be necessary.

Although every attempt has been made to prepare this Guide in a way that can be used across all Member States, it is freely acknowledged that it may not be wholly appropriate to every aspect of the project development process in some Member States. Nevertheless, the general principles of cost and risk identification will have some relevance in all institutional settings. With careful judgement therefore, desk officers should be able to make use of the Guide in most situations that they will encounter.

It is envisaged that the experience developed by desk officers and others in using this Guide will be used in the preparation of future revisions of the document.

Glossary

Consents procedures – Institutional processes whereby development approval is secured, including land use planning, environmental, operational and safety aspects.

Contingency – An amount included in the costing of a project to allow for unexpected factors which could result in the original cost estimate being exceeded.

Contractor – Specifically, any individual or group that enters into a binding agreement to provide specified goods or services; in the context of this Guide, a contractor is a construction company which undertakes to build a specified project for an agreed price and within an agreed timescale.

Cost over-run – An instance in which the provision of contracted goods or services are claimed to require more financial resources than was originally agreed between a project sponsor and a contractor.

Detailed design – Description of a construction process, in drawings and words, to a level that permits fully itemised costing of a project and the preparation of a clear programme of works to implement it.

Inflation – A general increase in the level of prices in a country, caused by aspects of that country's macro-economic policy or the impacts of the policies of its main trading partners. (To be distinguished from changes in the relative prices of particular goods and services which may result from technological developments or from localised increases in demand for those goods or services).

Outline design – Description of a construction process, in drawings and words, to a level that permits most consents procedures to be carried out and a general estimate of project costs to be made.

Procurement – The method whereby a contract to provide goods or services is established. Different methods involve different roles and responsibilities for the project sponsor and contractor respectively. Examples are: competitive tender based on a project sponsor's detailed design; design and build; and design, build, finance and operate (DBFO).

Programme – A group of projects, implemented with similar overall objectives, and usually financed from a common funding source such that financial over-runs in one project may affect the availability of funds to other projects in the programme.

Programme manager – The individual or institution responsible for delivering the programme as a whole.

Project – The specified construction works, including goods and services, that are the subject of a contract between a project sponsor and a contractor.

Project manager – The individual responsible for delivering a project within the cost and timescale agreed in the contract. The project manager may be employed either by the project sponsor or by the contractor. Alternatively he may be appointed independently by the institution providing a major part of the funding for the project.

Project sponsor – The individual or institution responsible for initiating a project and who thus enters into the contract with the construction contractor to procure the project. Alternative terms for the project sponsor include "client" or simply "owner".

Quantity surveyor – The professional responsible for detailed itemising of the works and materials involved in building a project and also for the pricing of these works and preparation of a detailed programme for implementing the project.

Risk – The probability that, despite careful project costing and planning, unforeseen events will occur during the implementation of a project which will affect the final cost and completion timescale.

Appendix

A: Poor Practice Projects

B: Good Practice Projects

A: Poor Practice Projects

Road Project

The project's costs were originally estimated at £9m but this increased to £12.24m. The increase was due to:

- design changes to allow for increased loadings and environmental standards (£1.75m)
- further land acquisition than was originally envisaged (£0.3m)
- inflation since the original estimate was made in 1993 and the project was completed in 1996 (£1m).

Sewerage Project

The project's costs were originally estimated at 4.7 MECU but increased by almost 20% to 5.6 MECU. The increase in costs was primarily due to the contractor going out of business during the construction phase of the project. The project was delayed for 8 months whilst new tender and contract documents were prepared. During this period of delay VAT increased by 2.5% which was unexpected and further contributed to the cost increase.

Road Project

The project's costs increased by 10% and was delayed by at least three months due to adverse weather conditions during the initial ground works stage. The increase in costs was due to:

- inflation over a two year period
- higher legal costs for land acquisitions – a higher number of cases required arbitration and had been referred on to the High Court
- unexpected ground conditions.

Road Project

The project's costs increased by 20% due to the following factors:

- the project was delayed because it was found that the contractor had no experience of a particular type of construction and sub-contractors had to be found
- land acquisition costs were higher than originally envisaged
- design changes due to unexpected ground conditions being experienced and the need for environmental features not originally envisaged.

Road Project

The project's costs increased by 20% due primarily to the fact that the implementing authority had little experience of a project of this scale. The costs for all elements of the project were flawed and it was only at the tendering stage that these flaws came to light.

Sewerage Project

The project's costs increased by 20% due primarily to an underestimate of the time and cost involved in on-site demolitions and excavations.

Company X – Project Funded by a Major International Funding Institution (non-ERDF)

The Problem

It was expected that any investment costs after the initial development costs would be covered by internal financing. Therefore total planned investment cost did not contain essential investments for further developing the project, nor did the investment plan incorporate early year operational losses.

The Recommendations

For proper assessment of project finance deals it is essential to compose an investment plan which includes all costs required to complete a project, including operational losses during the start-up years. It allows the partners and participating banks in the transaction to provide sufficient funding, without being fully dependent on future year internally generated cash. In these transactions it is important that the estimated finance costs during the start-up phase are taken into account and that at least 10% of capital expenditure is incorporated in the investment plan under a clearly specified contingency cost category. Although project funds and guarantee agreements usually provide for obligations of the sponsor to fill eventual financing gaps, an agreement among partners at the start of the project on how to finance cost increases, mitigates the project's financial risks.

A strong strategic investor's financial strength was essential when additional funds were required to compensate for the lower than expected cash generation for investment purposes and to finance cost over-run on capital expenditures.

Major Project in CIS (non-ERDF financial institutions)

Reasons for Cost Over-Runs

In general, the underlying theme for cost over-runs is inexperience in the CIS system, compounded by overconfidence in the Western system. In the planning and development stages, the project was approached too much from the Western perspective, applying Western project rationale without adequate attention to the project country's perspective and cultural differences. Insufficient attention was given to important details, labour resources, construction equipment, logistics and scheduling that would be affected by the culture, traditions and labour practices. The primary reasons for cost over-runs are as follows:

General Lack of Experience in Foreign Projects

The sponsor and the consultant company relied too heavily on the assurances offered by their local partners in the joint venture. The sponsor should have insisted on a more thorough investigation of the local construction company's capabilities, including their ability to supply the promised construction equipment and skilled labour, and their past project experience. The lack of investigation and follow-through greatly impacted upon the completion of construction and of increased costs throughout the entire project. There was a complete underestimation of the local labour force regarding their productivity and technical proficiency. The sponsor and the consultant company did not verify the validity of the local construction company's cost estimate and did not budget sufficient contingency funds in view of the extremely tight construction and start-up schedule for an operation of this magnitude.

Freight Costs

An inadequate assessment of the complexity of the project site along with the long logistic chain proved very costly. Equipment which the local construction company failed to supply had to be air freighted from the USA to mitigate construction delays. More costly air and truck transportation replaced rail transport in order to speed delivery of the spare parts and maintenance inventory requirements of the operation.

Underestimation Of Costs For Spare Parts and Maintenance

The need for replacement parts and maintenance costs for the processing cycle were underestimated. Delivery delays necessitated a storage of 12 months of inventory on-site rather than the initial 3 months plan.

Operating Cost Over-Runs

These are driven mostly by labour, maintenance, power and freight. The labour costs were higher and productivity lower than budgeted. Higher maintenance costs were due to the fact that more replacement parts were required than budgeted for. Power rates were raised after the project was operational, making them higher than originally estimated. Freight costs were much higher than planned driven by a substantial use of air and truck freight to satisfy maintenance inventory requirements.

Inadequate Design of the Plant

The initial feasibility study was inadequate. Final engineering and design changes had to be made to include more buildings and equipment. Extra costs were incurred for materials, engineering, procurement, equipment, labour and general management throughout the entire fabric of the operation.

B: Good Practice Projects

In projects that demonstrate good practice, the project sponsors can usually give positive answers to the following questions:

- is the customer able to procure and manage major projects as this is crucial?
- has he the experience in procuring contracts?
- have the customer/contractor worked together before?
- does the customer appreciate the key issues and key areas of risk?
- does the customer understand and know what he wants?

B.1 Airport Project

The project involved a major new two story extension to a terminal building costed at over £35m. The contract was awarded on a Design, Manage and Construct basis. During the initial 18 month design period detailed work was undertaken to identify the project budget. A Guaranteed Maximum Price (GMP) was agreed between the client and the contractor. The key success factors were:

- close working relationship between the client and the contractor from the beginning, involving senior staff commitment;
- clear definition of the client's design at the outset;
- early agreement on the client's total budget;
- sufficient time to develop the client's brief and carry out value management exercise (which led to the GMP);
- use of client's own in-house designers for specialist components thereby avoiding specification problems;
- a flexible approach during the design phase to incorporate client changes;
- agreement of a detailed specification for the project prior to construction work;
- appointment by the client of a senior resident project manager to control the interface between the contractor, the airport management and the public;
- a formal two-day team-building exercise between all members of the client and contractor project team was held to develop a good working relationship;
- experienced project management team put in place.

B.2 Road Project

The project involved the construction of a major road interchange valued at over £25m. The contract was awarded on a fixed price Design and Construct basis.

- the client prepared a detailed specification stating exactly what technical, aesthetic and contractual requirements were to be;
- the timescales for preparation of tenders and completion of the project were realistic;
- detailed site investigations were made the responsibility of the tenderers;
- employer, recognising the difficult conditions, agreed to pay for more ground investigations;
- the client and the contractor had worked together in the past.
- the client adhered to the brief and no variations were issued;
- the client placed an experienced engineering team to audit the contractor's QA system and provide on-going support in terms of new engineering approaches and traffic management.